CLAIMS

What is claimed is:

1. A method for fabricating and protecting a semiconductor device comprising the steps of:

providing a substrate;

depositing a plurality of semiconductor layers on the substrate, the plurality of semiconductor layers having an interface serving as a channel;

depositing an encapsulation layer having a first surface on at least one layer of the plurality of layers;

depositing ohmic metal contacts on the plurality of layers; and

alloying the ohmic metal contacts, wherein the encapsulation layer protects the channel and prevents ohmic metal in the ohmic metal contacts from migrating during the step of alloying.

2. The method of claim 1, wherein the substrate comprises SiC.

3. The method of claim 1, wherein the encapsulation layer comprises SiN.

4. The method of claim 1, wherein the plurality of layers comprise a first layer, the first layer comprising GaN.

5. The method of claim 4, wherein the plurality of layers further comprises a second layer deposited over the first layer, the second layer comprising AlGaN.

6. The method of claim 1, wherein the encapsulation layer has a thickness in the range of 50-200 nanometers.

7. The method of claim 5, wherein the step of depositing ohmic metal contacts comprises the steps of:

removing a portion of the encapsulation layer and the second layer; and

depositing the ohmic metal contacts where the portion of the encapsulation layer and the second layer is removed.

8. The method of claim 1, further comprising the step of removing a portion of the encapsulation layer, thereby creating an opening.

9. The method of claim 8, further comprising the step of depositing a refractory metal layer in the opening and on a portion of the first surface of the encapsulation layer.

10. The method of claim 9, wherein the refractory metal layer comprises a metal selected from the group consisting of molybdenum, tungsten, and tungsten-silicide.

11. The method of claim 9, wherein the refractory metal layer has a thickness in the range of 100-400 nanometers.

12. The method of claim 11, wherein the refractory metal layer has a thickness of 100 nanometers.

13. The method of claim 9, further comprising the step of depositing a gate contact on the refractory metal layer.

14. The method of claim 1, wherein the ohmic metal contacts comprise a combination of titanium, aluminum, nickel, and gold.

15. The method of claim 1, wherein the step of alloying further comprises the step of exposing the ohmic metal contacts to a temperature of at least 800°C for at least 30 seconds.

16. A method for fabricating and protecting a semiconductor device comprising the steps of:

providing a substrate;

depositing at least one semiconductor layer on the substrate;

depositing ohmic metal contacts on the at least one semiconductor layer, the ohmic metal contacts having a first surface and a first edge;

depositing an encapsulation layer on at least a portion of the first surface and the first edge of the ohmic metal contacts; and

alloying the ohmic metal contacts, wherein the encapsulation layer prevents migration of ohmic metal in the ohmic metal contacts during the step of alloying.

17. The method of claim 16, wherein the substrate comprises SiC.

18. The method of claim 16, wherein the encapsulation layer comprises SiN.

19. The method of claim 16, wherein the at least one semiconductor layer comprises a first layer, the first layer comprising GaN.

20. The method of claim 19, wherein the at least one semiconductor layer further comprises a second layer deposited over the first layer, the second layer comprising AlGaN.

21. The method of claim 16, wherein the encapsulation layer has a thickness in the range of 50-200 nanometers.

22. The method of claim 20, wherein the step of depositing ohmic metal contacts, further comprises the steps of:

removing a portion of the second layer; and

depositing the ohmic metal contacts where the portion of the second layer is removed.

23. The method of claim 16, wherein the ohmic metal contacts comprise a combination of titanium, aluminum, nickel, and gold.

24. The method of claim 16, wherein the step of alloying comprises the step of exposing the ohmic metal contacts to a temperature in excess of 800°C for at least 30 seconds.

25. A semiconductor device comprising:

a substrate;

a plurality of semiconductor layers deposited on the substrate, the plurality of layers having an interface, the interface serving as a channel;

an encapsulation layer having a first surface deposited on a portion of at least one layer in the plurality of layers;

alloyed ohmic metal contacts deposited on the plurality of semiconductor layers, wherein the encapsulation layer prevents migration of the ohmic metal in the alloyed ohmic metal contacts and protects the channel when the alloyed ohmic metal contacts are alloyed.

26. The apparatus of claim 25, wherein the substrate comprises SiC.

27. The apparatus of claim 25, wherein the encapsulation layer comprises SiN.

28. The apparatus of claim 25, wherein the plurality of semiconductor layers comprise a first layer, the first layer comprising GaN.

29. The apparatus of claim 28, wherein the plurality of layers further comprises a second layer deposited on the first layer, the second layer comprising AlGaN.

30. The apparatus of claim 25 wherein the encapsulation layer has a thickness in the range of 50-200 nanometers.

31. The apparatus of claim 29, wherein a portion of the encapsulation layer and the second layer is removed, and wherein the ohmic metal contacts are deposited where the portion of the encapsulation layer and second layer is removed.

32. The apparatus of claim 25, wherein the semiconductor device further comprises a refractory metal layer deposited on at least a portion of the second layer, and at least a portion of the first surface of the encapsulation layer.

33. The apparatus of claim 32, wherein the refractory metal layer comprises a metal selected from the group consisting of molybdenum, tungsten, and tungsten silicide.

34. The apparatus of claim 33, wherein the refractory metal layer has a thickness in the range of 100-400 nanometers.

35. The apparatus of claim 34, wherein the refractory metal layer has a thickness of 100 nanometers.

36. The apparatus of claim 32, wherein the semiconductor device further comprises a gate contact deposited on the refractory metal layer.

37. The apparatus of claim 25, wherein the ohmic metal contacts comprise a combination of titanium, aluminum, nickel, and gold.

38. The apparatus of claim 25, wherein the ohmic metal contacts are alloyed by exposure to a temperature of at least 800°C for at least 30 seconds.

39. A semiconductor device comprising:

a substrate;

at least one semiconductor layer deposited on the substrate;

alloyed ohmic metal contacts deposited on the at least one semiconductor layer, the alloyed ohmic metal contacts having a first surface and a first edge; and

an encapsulation layer, the encapsulation layer deposited on a portion of the first edge and first surface of the alloyed ohmic metal contacts, wherein the encapsulation layer prevents migration of the ohmic metal in the alloyed ohmic metal contacts when the alloyed ohmic metal contacts are alloyed.

40. The apparatus of claim 39, wherein the substrate comprises SiC.

41. The apparatus of claim 39, wherein the encapsulation layer comprises SiN.

42. The apparatus of claim 39, wherein the at least one semiconductor layer comprises a first layer, the first layer comprising GaN.

43. The apparatus of claim 42, wherein the at least one layer further comprises a second layer deposited over the first layer, the second layer comprising AlGaN.

44. The apparatus of claim 39 wherein the encapsulation layer has a thickness in the range of 50-200 nanometers.

45. The apparatus of claim 43, wherein a portion of the second layer is removed, and wherein the alloyed ohmic metal contacts are deposited in the region where the portion of the second layer is removed.

46. The apparatus of claim 39, wherein the alloyed ohmic metal contacts comprise a combination of titanium, aluminum, nickel, and gold.

47. The apparatus of claim 39, wherein the alloyed ohmic metal contacts are alloyed by exposure to a temperature of at least 800°C for at least 30 seconds.